

XMM-Newton observations of XTE J1817-330 and XTE J1856+053

Gloria Sala, Jochen Greiner, Eugenio Bottacini and Frank Haberl

Max-Planck-Institut für extraterrestrische Physik, PO Box 1312, 85741 Garching b.M., Germany

Abstract. The black hole candidate XTE J1817-330 was discovered in outburst on 26 January 2006 with RXTE/ASM. One year later, on 28 February 2007, another X-ray transient discovered in 1996, XTE J1856+053, was detected by RXTE during a new outburst. We report on the spectra obtained by XMM-Newton of these two black hole candidates.

Keywords: Black holes, X-ray binaries – X-rays: individual: XTE J1817-330, XTE J1856+053

PACS: 97.60.Lf, 97.80.Jp

XTE J1817-330

XTE J1817-330 was discovered by the Rossi X-ray Timing Experiment (RXTE) on 26 January 2006 [1] with a flux of $0.93(\pm 0.03)$ Crab (2–12 keV) and a very soft spectrum, typical for black hole transients. We obtained a Target of Opportunity Observation (TOO) with XMM-Newton (0.1–10.0 keV) on 13 March 2006 (obs. ID. 0311590501, 20 ks), when the source flux detected by the All Sky Monitor (ASM) on board RXTE had faded to ~ 300 mCrab [2] (left panel in Fig. 1).

We fit simultaneously the data of all XMM-Newton instruments active during the observation: EPIC-pn (0.6–10.0 keV; Burst mode), RGS1 (0.3–2.0 keV) and OM (U and UWV1 filters) (Fig. 2). We use a 2-component model consisting of a thermal accretion disk (*diskpn* model available in *xspec* [3]) plus a comptonization component (*compTT* model [4]) to fit the spectrum of XTE J1817-330. The inner radius in the *diskpn* model is fixed to $6R_g$. We obtain the best fit for the *diskpn* + *compTT* model ($\chi^2_\nu = 1.18$) with $N_H = 1.55(\pm 0.05) \times 10^{21} \text{ cm}^{-2}$, a disk with $kT_{\text{in}} = 0.70(\pm 0.01) \text{ keV}$ and a comptonization component with $kT_e = 50 \text{ keV}$ (fixed) and $\tau = 0.15(\pm 0.02)$. The observed X-ray flux is $8.6(\pm 0.8) \times 10^{-9} \text{ erg cm}^{-2} \text{ s}^{-1}$ (0.4–10 keV), and the unabsorbed X-ray luminosity of the source at the time of the observation $L_{(0.4-10 \text{ keV})} = 1.2(\pm 0.1) \times 10^{38} (D/10 \text{ kpc})^2 \text{ erg s}^{-1}$.

The normalization constant K of the *diskpn* model is related to the mass of the compact object M , the distance to the source D , and the inclination i of the disk as $K = \frac{M^2 \cos(i)}{D^2 \beta^4}$, where β is the color/effective temperature ratio. Furthermore, the accretion rate can be obtained from the mass of the compact object and the maximum temperature of the disk [3]. Assuming $\beta = 1.7$ and using the best fit value for the normalization of the *diskpn* model ($K_{\text{diskpn}} = 0.024 \pm 0.002$), we can compare the accretion rate for different possible masses, distances, and inclinations with an upper limit for the accretion rate. At the time of the XMM-Newton observations, the flux of the source had decreased by a factor 6 with respect to the maximum registered by RXTE. Taking the Eddington limit as the

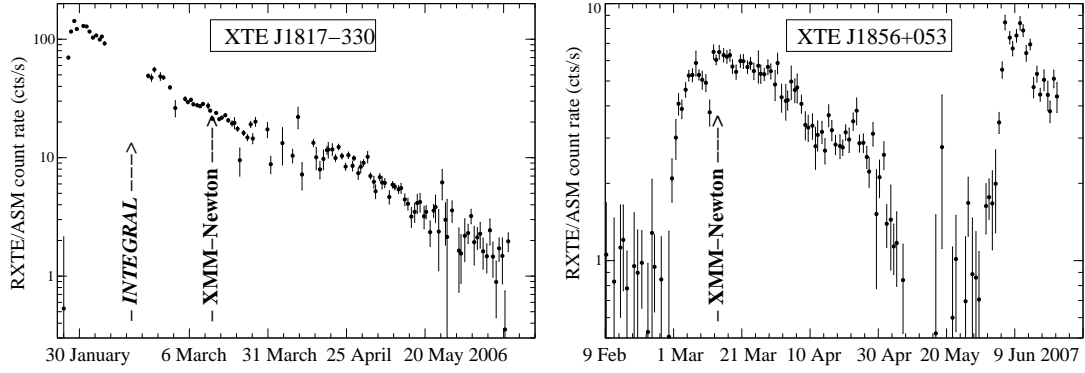


FIGURE 1. RXTE/ASM light-curves of XTE J1817-330 (left) and XTE J1856+053 (right). The dates of the XMM-Newton and INTEGRAL observations presented here are indicated.

upper limit for the accretion rate at the maximum of the burst, the accretion rate at the time of the observation could not be higher than 16% of $\dot{M}_{\text{Edd}}^{\text{acc}}$. This sets an upper limit for the mass of the central object of $6 M_{\odot}$ (see [5] for more details).

INTEGRAL observed XTE J1817-330 in hard X-rays (20–150 keV) as a TOO on 15–18 February 2006 [6] (200 ks exposure). We fit simultaneously JEM-X (6–30 keV) and IBIS/ISGRI (20–200 keV) spectral data obtained on 15–18 February 2006 with a two component model, $\text{diskbb} + \text{pow}$. The best fit ($\chi^2_{\nu} = 1.3$) is obtained with $kT_{\text{in}} = 0.95(\pm 0.04)$ keV, $K_{\text{diskbb}} = \left(\frac{R_{\text{in}}/\text{km}}{D/10\text{kpc}}\right)^2 \cos i = 1500 \pm 400$, photon index $\Gamma = 2.64 \pm 0.04$ and power-law normalization $K = 4.2 \pm 0.4 \text{ ph keV}^{-1} \text{ cm}^{-2} \text{ s}^{-1} @ 1 \text{ keV}$.

XTE J1856+053

On 28 February 2007 a new outburst of the previously known transient source XTE J1856+053 was detected with RXTE [7]. We obtained a TOO observation with XMM-Newton (0.1–10.0 keV) on 14 March 2007 (obs. ID. 0510010101, 5 ks for RGS, 1.5 ks for EPIC-pn), when the source flux detected by the RXTE/ASM was maximum, ~ 80 mCrab [8] (right panel in Fig. 1).

We fit simultaneously XMM-Newton EPIC-pn (0.55–10.0 keV, in Timing mode), RGS1 and RGS2 (0.3–2.0 keV) data (Fig. 2). We fit the spectrum with a thermal accretion disk (diskpn). No indication of a hard component is evident in the residuals, but an excess is present below 1 keV, leading to a poor reduced χ^2 of 1.99. Adding a recombination emission edge at 0.87 keV (corresponding to O VIII K-shell) with plasma temperature $kT = 50(\pm 3)$ eV improves the fit. The significance of this feature is however to be taken with care, since the excess could be caused by some redistribution of higher energy photons to lower energies not properly taken into account by the calibration. The best fit ($\chi^2_{\nu} = 1.16$) is then obtained with $N_{\text{H}} = 4.45(\pm 0.05) \times 10^{22} \text{ cm}^{-2}$, and a disk with $kT_{\text{in}} = 0.76(\pm 0.01)$ keV and $K_{\text{diskpn}} = \frac{M^2 \cos i}{D^2 \beta^4} = (8.5 \pm 0.4) \times 10^{-3}$. The observed X-ray flux is $1.0(\pm 0.1) \times 10^{-9} \text{ erg cm}^{-2} \text{ s}^{-1}$ (0.5–10.0 keV), which corrected for absorption corresponds to an unabsorbed X-ray luminosity $L_{(0.5-10.0\text{keV})} =$

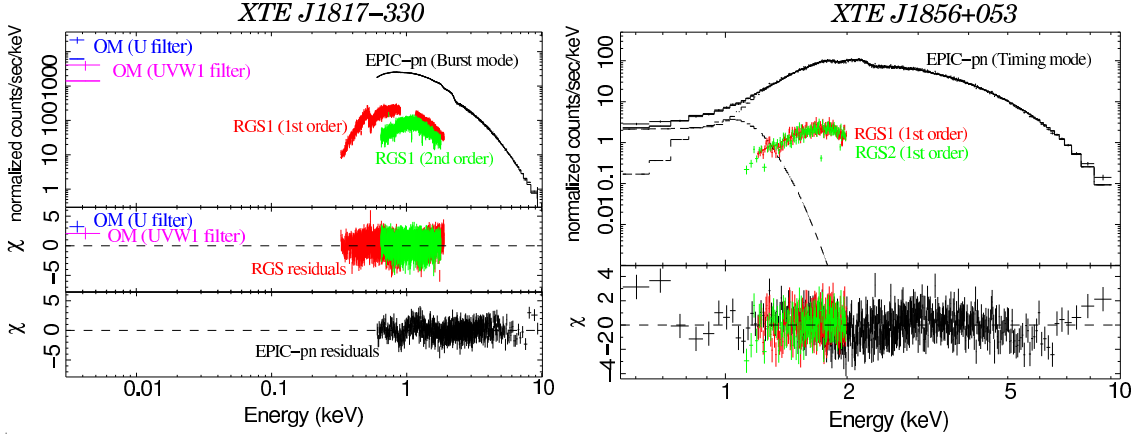


FIGURE 2. XMM-Newton spectra of XTE J1817-330 (left) and XTE J1856+053 (right).

$$4.0(\pm 1.5) \times 10^{38} (D/10\text{kpc})^2 \text{erg s}^{-1}.$$

The low temperature of the accretion disk favours a black-hole as the accreting compact object. With the normalization constant K of the *diskpn* model we can put some constraint to the mass of the compact object M , as done above for XTE J1817-330. At the time of the XMM-Newton observations, the flux of the source was at the maximum of the first burst detected in March 2007. However, a brighter burst was detected by RXTE/ASM in June 2007. At the time of our XMM-Newton observations, the flux was 70% of the maximum detected in June 2007. Taking the Eddington limit as the upper limit for the accretion rate at the maximum in June 2007, the accretion rate at the time of the XMM-Newton observation could not be higher than $0.7M_{\text{Edd}}^{\text{acc}}$. This sets an upper limit for the mass of the central object of $4.2 M_{\odot}$.

ACKNOWLEDGMENTS

We thank Norbert Scharrel and the XMM-Newton team for carrying out the TOO observations presented here. XMM-Newton and INTEGRAL projects are ESA Science Missions directly funded by ESA Member States and the USA (NASA), with support from BMWI/DLR (FKZ 50 OX 0001), the Max-Planck Society and the Heidenhain-Stiftung. GS and EB are supported through DLR (FKZ 50 OR 0405).

REFERENCES

1. Remillard et al. *ATel* #714 (2006)
2. Sala & Greiner, *ATel* #791 (2006)
3. Gierliński et al. *MNRAS* **309**, 496 (1999)
4. Titarchuk, *ApJ* **434**, 313 (1994)
5. Sala, Greiner, Ajello, Bottacini, & Haberl, *A&A*, in press, (DOI: 10.1051/0004-6361:20077360)
6. Goldoni et al. *ATel* #742 (2006)
7. Levine et al. *ATel* #1024 (2007)
8. Sala, Greiner, & Haberl, *ATel* #1062 (2007)